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A BOG FOREST[1]

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In a previous paper (4, 1917) the writer has described forest succession in Puget Sound sphagnum bogs, and in other papers (4, 1913; 1914; 1919) has listed the trees growing in various sphagnum bogs of the Puget Sound region and Alaska. All of these are comparatively early stages in bog succession. None of them have reached a stage where the forest is dominant.

An area of about three acres near Victoria, British Columbia, shows a very late stage where the forest has become the dominant vegetation, and sphagnum is no longer found living. This area was visited in July, 1920, and a more careful study was made during several visits to it at various times in July, 1921. The area is at present bordered on the south by a meadow, on the east and north by Lost Lake, and on the west by the Patricia Bay line of the Canadian National Railway.

The forest consists of a pure stand of lodge-pole pine, *Pinus contorta.* The trees are of good size for this species, many of them being 20 to 30 feet tall and 6 to 10 inches thick at the base. A few are 12 inches thick. The stand of trees is very dense over nearly all of the area, and many young trees have been killed by the shade of the taller ones. The trunks of these trees are straight and slender. They do not have the scrubby form that this species does on rocky, exposed places, nor the stunted appearance that it has in the early stages of forest succession in Puget Sound bogs. Very few pine seedlings were found, and these only on the border along the west side, where the forest was cleared a few years ago when the railroad was built, and Nature was then allowed to take her course again.

Lodge-pole pine is common on this portion of Vancouver Island. It is found around lakes, both in swampy places and on rocky shores, and on the thin soil of rocky hills. It is found practically to the top of Mount Benson, near Nanaimo. Glendenning (1, 1918) says that it is frequent in bogs and on gravel ridges in the Cowichan district on Vancouver Island. Whitford and Craig (5, 1918) state that this species is general throughout the province of British Columbia, from the international boundary to the Yukon drainage, being found at an altitude of 5,000 to 6,000 feet, and attaining a height of 50 to 75 feet and a diameter of 12 to 24 inches.

The undergrowth in the bog forest under consideration consists of a dense thicket of Labrador tea, *Ledum groenlandicum,* and salal, *Gaultheria shallon.*

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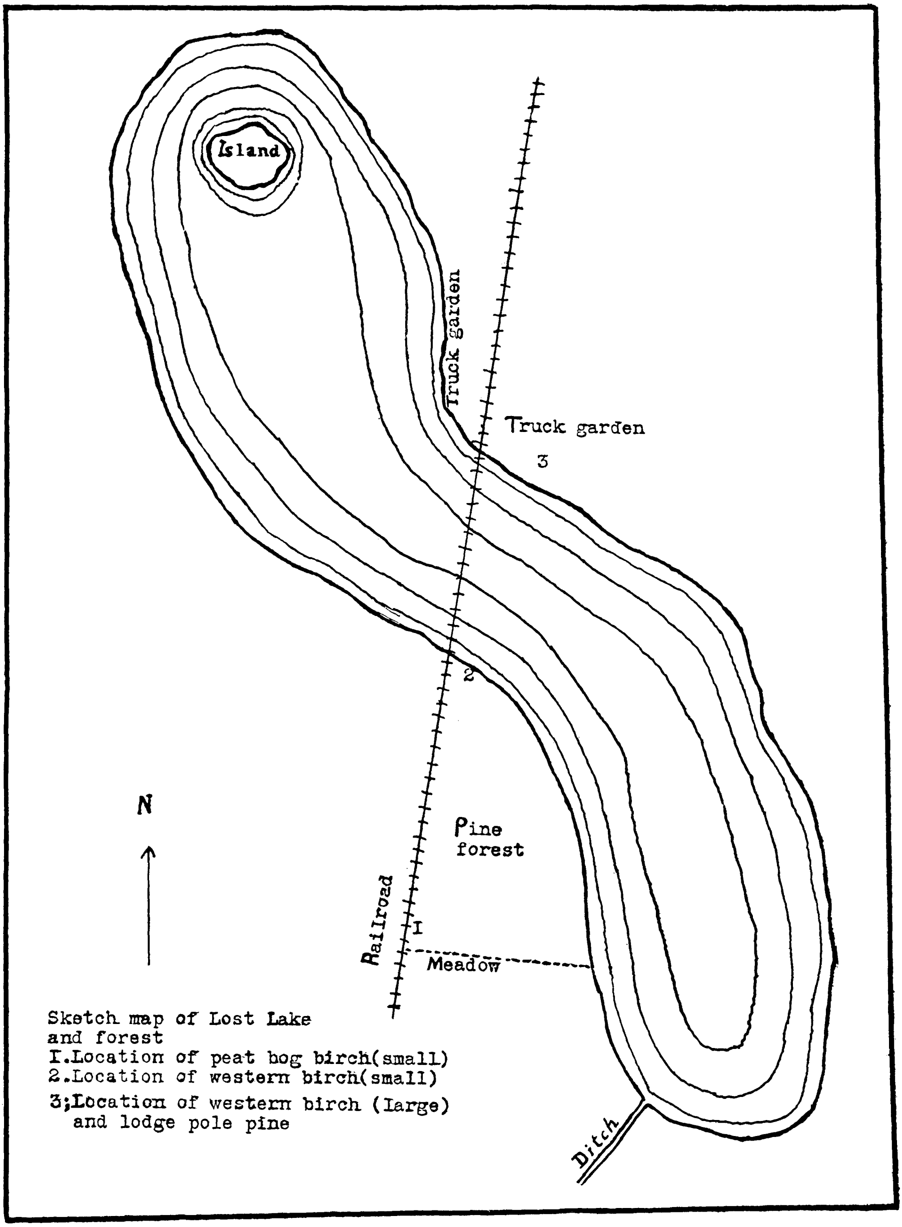
Island
Truck garden
Truck garden
3
2
N
Pine forest
Railroad
1
Meadow
Ditch
Sketch map of Lost Lake and forest
1.Location of peat bog birch(small)
2.Location of western birch(small)
3;Location of western birch (large) and lodge pole pine

FIG. 1. Sketch map of Lost Lake, showing the location of the pine forest and birch areas.

Both of these are general throughout the forest, though the salal is taller and more abundant in the occasional places 15 to 25 feet in diameter where the growth of trees is less dense. Vigorous young salal plants are very numerous, most of them growing from the long horizontal roots, characteristic of the species. It is increasing rapidly.

Labrador tea forms a dense growth also and is very tall. Much of it is 6 feet high, and in places it grows almost as a vine, clambering up among the salal and pines to a height of 12 feet in some cases. This species is very characteristic of sphagnum bogs throughout the Puget Sound region and is very common in a bog (Rithet bog) only a few miles from this forest. It is reported by Glendenning (1, 1918) under the synonym of *L. latifolium* in the bogs in the Cowichan district.

This species is not increasing to any great extent in the bog forest under discussion. Young plants are scarce. The ones found are mostly growing from the running stems and roots that characterize the species in bogs. The leaves on the new growth of the taller specimens are larger and less woolly than on the older portions. This is the condition usually seen where this plant grows on the borders of bogs, outside of the area in which sphagnum is dominant. While Labrador tea is thus practically at a standstill, salal is advancing rapidly — a veritable conquering host. The *Pinus-Gaultheria-Ledum* association is dominant, but the first and third members of the association seem to have reached a practically static condition.

Only one other species characteristic of sphagnum bogs was found by the writer in this bog forest. This is the peat bog birch, *Betula glandulosa,* a few specimens of which are found in the extreme southwest corner. They are from 6 to 12 feet tall. This birch is common in and around the Rithet bog only a few miles distant. It is also common in and around certain sphagnum bogs in the Puget Sound region. Newcombe (2, 1921) states that this species is rare in the Victoria region, being reported from Alberni only, except as noted above. He says that it was much more abundant around Lost Lake in 1894 and also in 1908 than it is now. He states also (2, 1921) that the tideland spruce is found in the Lost Lake forest near the specimens of peat bog birch. This spruce is found in many Puget Sound sphagnum bogs.

Except around the margins, plants other than pine, salal, and Labrador tea are not common. Young specimens of hardhack, *Spiraea douglasii,* are occasionally found, only a few being mature enough to blossom. Small specimens of cascara, *Rhamnus purshianna,* are occasional, but none seen within the forest were more than 3 feet tall. Other plants occasionally found are black-cap, *Rubus leucodermis;* evergreen blackberry, *R. laciniatus;* fireweed, *Epilobium angustifolium;* bed straw, *Galium* sp.; nettle, *Urtica* sp., and velvet grass, *Holcus lanatus.* Several species of mosses were found growing on the substratum, but no living sphagnum was found, though careful search was made for it. Newcombe (2, 1914) found sphagnum along the lake on the edge of this area a few years ago.

On the south side the forest ends abruptly in a straight line, where it is bordered by the meadow. The clearing here has been done so completely that no trace of the forest remains. The railroad along the west side of the bog is on a trestle. Since the clearing of this right-of-way at the time of the construction of the railroad, less than ten years ago, it has been but little disturbed and salal and Labrador tea are making a vigorous growth, with pine seedlings numerous and thrifty. Seedlings of alder, *Alnus oregona,* are also occasionally found.

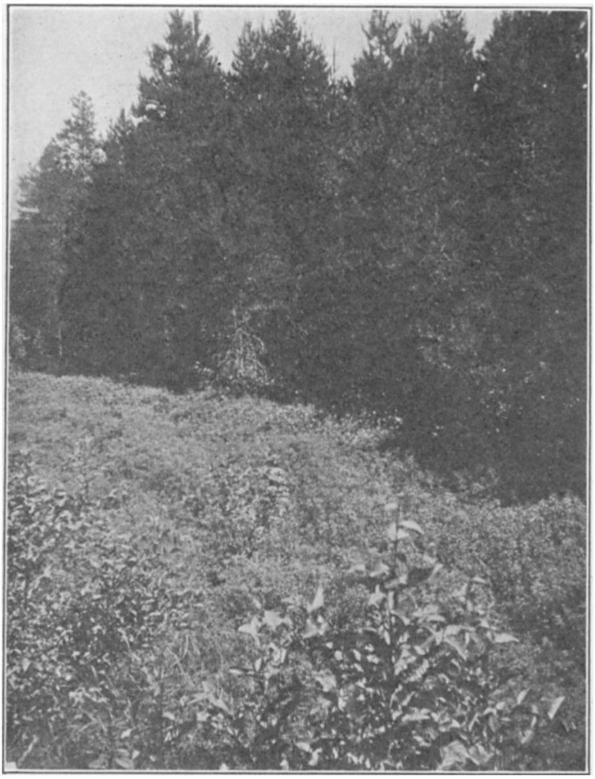

FIG. 2. Margin of the forest along the railroad, showing dense growth of Labrador tea on the cleared portion. Young alders in the foreground.

In the northwest corner are a few small specimens of the western birch, *Betula occidentalis*. None of these are more than 5 feet tall, though on the north side of the lake in an area which is now cleared, but was evidently similar to the one under discussion, specimens 8 inches in diameter and 20 feet tall are still standing, and stumps 24 inches in diameter are still seen.

Newcombe (2, 1921) says that this species is rare on Vancouver Island, being reported from only two locations, these both near Victoria.

Along the shore of the lake, which forms the north and east border of the bog, is a dense thicket of deciduous trees and shrubs. The crab-apple, *Pyrus rivularis,* so commonly found on the borders of bogs in the Puget Sound region, is dominant among these. The individuals are numerous and some of them are 15 feet tall. A few cascara trees of about the same size are also found, and dogwood, *Cornus occidentalis,* of similar size is fairly abundant. There are also a few specimens of elder, *Sambucus* sp.

In the tension line between this thicket and the bog forest are a few conifers other than pine. Nearly all of the specimens are less than 6 feet tall. The Douglas fir, *Pseudotsuga taxifolia,* and western hemlock, *Tsuga heterophylla,* occur occasionally. The white fir, *Abies grandis,* is more common, specimens from 1 to 6 feet tall being fairly abundant in places. The edge of the forest seems to be static, so far as the pines are concerned, no pine seedlings being found in the thicket.

The lake margin bordering on this thicket shows three fairly distinct zones. The outer one is composed of a dense growth of two pond-weeds, *Potamogeton* sp. One of these species has floating leaves, and among these the common duckweed, *Lemna minor,* is common. The second zone consists of the yellow pond lily, *Nymphaea polysepala,* a bulrush, *Scirpus* sp., growing from 6 to 10 feet tall, and the cat-tail, *Typha latifolia.* The third zone occupies the margin of the water. It is made up mainly of water celery, *Oenanthe sarmentosa,* and water parsnip, *Sium suave,* with some purple marsh locks, *Comarum palustre,* and buck bean, *Menyanthes trifoliata,* and a buttercup, *Ranunculus loffi.* A liverwort, *Ricciocarpus* sp., forms numerous rosettes on the mud. The duckweed is found in the last two zones as well as the first.

The substratum on the margin of the lake is firm at the surface, and the zones of vegetation.

The surface of the substratum within the pine forest is thickly covered shallow margin of the lake is being slowly filled by the growth of these three with pine needles mixed with a small amount of other material of vegetable origin. Under the surface decay has begun. The depth of the layer of pine needles in various stages of decay is from 6 to 12 inches. Beneath this is a layer of old sphagnum usually 12 inches or more thick. Six holes were dug in widely separated portions of this forest and the same conditions were found in all. Leafy stems of sphagnum an inch or more long were still intact. Microscopic examination of several specimens from each hole was made, and in all cases the hyaline cells of sphagnum, with their characteristic markings, were easily recognized.

Samples taken with a Davis peat sampler showed conditions similar to those found in sphagnum bogs of Washington, Oregon, and British Columbia in which living sphagnum still forms much of the surface of the substratum.

Hard soil was not reached anywhere in the forest at a depth of 20 feet. In the adjoining meadow blue clay was found at a depth of 18 to 20 feet. The substratum below the sphagnum layer was everywhere very watery. Samples taken at a depth of 16 to 20 feet in the forest were brown and plastic, and, when rolled into balls and dried in the sun, they shrank to about half their original size and became very hard. Above this depth the samples were more or less fibrous and occasionally contained small particles of rotten wood. Small roots, together with material resembling the leaves of *Carex,* made up much of the solid material in these samples. Newcombe (2, 1914) states that the railway engineers did not find a sufficiently solid foundation for their roadbed, even at the depth of 100 feet.

A drainage ditch extends southwestward from the southwestern side of the lake, south of the forest. It was dug in 1894 (Newcombe, 2, 1914). It was learned that the level of the lake has been lowered by means of this ditch. On the north side of the lake, both east and west of the railroad, there are truck gardens on which cabbage, celery, head lettuce, carrots, parsnips, and mangels were seen growing. These areas are only 2 to 3 feet above the present level of the lake, and are stated to have been formerly covered with water and to be still very wet during the rainy season. It is probable that forest succession has been hastened somewhat by this drainage, though it seems impossible that the dense pine forest can be entirely due to this.

The Rithet bog, situated on the Rithet farm only a few miles from the area just described, furnishes some interesting comparisons. References to this bog have already been made. The area around this bog has been cleared and some of it is used for pasture. It has also been drained, but apparently with less success than has attended the efforts at Lost Lake. Water stood in the ditch that had been dug along the north side of it, but no movement of the water could be detected during any of the visits made to it. The sphagnum in the bog is mostly dead, though there are a good many small areas on which it grows during the rainy season and dries up during the summer.

The bog has a flora similar to that of Puget Sound bogs in Washington. Labrador tea; swamp laurel, *Kalmia polifolia;* sundew, *Drosera rotundifolia;* cranberry, *Oxycoccus oxycoccus;* cotton grass, *Eriophorum* sp.; the peat bog birch, and the lodge-pole pine are abundant. All of this list except the peat bog birch are mentioned by Glendenning (1, 1918) as being found in the bogs in the Cowichan region. A few small specimens of Douglas fir are also found. Other plants found in the bog, but not characteristic of a true sphagnum bog stage of succession, are the common brake, *Pteridium aquilinum,* fireweed, hardhack, and salal. The birches along the drainage ditch form a dense growth 10 to 15 feet high, but farther into the bog they are smaller and more scattering.

At the south side of the bog there is a strip two to four rods wide on which there is a practically pure stand of lodge-pole pine. The conditions in this strip both as to flora and substratum are strikingly similar to those in the forest at Lost Lake.

Five lines of evidence point to the conclusion that the Lost Lake area is a case where the forest has been a successful invader of a sphagnum bog, finally becoming the dominant vegetation. (1) The dominance of the pines. (2) The abundant survival of Labrador tea and the occasional survival of the peat bog birch. (3) The presence of the layer of dead sphagnum. (4) The similarity between the deeper layers of the substratum in this area and the corresponding layers of bogs in Washington and Oregon where living sphagnum still forms much of the surface. (5) The similarity between this bog and the strip of forest along the edge of the Rithet bog which still has a characteristic bog flora.

It must be remembered, however, that drainage and clearing of the surrounding area, both tending to drier conditions, have undoubtedly hastened succession.

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